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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/742,127	12/22/2000	Young-Hee Mun	12597-P66182US0	7925

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 07/09/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Offic Action Summary	Application No.	Applicant(s)	
	09/742,127	MUN, YOUNG-HEE	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondenc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) *9-16* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-8 and 17-19* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12/22/2000* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Election/Restrictions

Claims 9-16 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in Paper No. 6.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 8 and 17-19 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The applicant cites the limitation of "greatly increased" in line 6-7 of claim 8, "greatly" is indefinite because it is unclear how "greatly increased" differs from generically increased, likewise for claims 17-19.

3. The following is a quotation of the fourth paragraph of 35 U.S.C. 112:

> A claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be constructed to incorporate by reference all of the limitations of the claim to which it refers.

4. Claim 18 is rejected under 35 U.S.C. 112, fourth paragraph, as failing to further limit the subject matter of a previous claim. Claim 17, which claim 18 is dependent cites the limitation of " a predetermined thermal history" and the specification defines only one predetermined thermal history of 1000°C for 64 hours in a N_2 ambience on page 12.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-3 and 6-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nagasawa et al (US 4,376,657).

Nagasawa et al discloses a single crystal silicon wafer is annealed in a non-oxidizing atmosphere at a temperature in the range of 950-1300°C for more than ten minutes and the wafer next annealed at a temperature in the range of 600°-800°C for at least one hour (col 3, ln 54-68 and claim 1 and col 4, ln 37-44). Nagasawa et al also discloses annealing at 1270°C for two hours followed by a second anneal at 650°C (FIG 5 and col 5, ln 19-40).

Nagasawa et al teaches a first annealing, i.e. heat treatment, in a range of 950-1300°C, but does not teach a heat treatment at a temperature greater than 1200°C. It would have been

obvious to a person of ordinary skill in the art at the time of the invention to modify Nagasawa et al by conducting the first annealing at a temperature greater than 1200°C because a prima facie case of obviousness exists from the overlapping ranges. MPEP § 2144.05

Referring to claim 2, Nagasawa et al discloses a first heat treatment of more than ten minutes.

Referring to claim 3, Nagasawa et al discloses a non-oxidizing atmosphere, this reads on applicant's hydrogen, inert or first mixed gas of hydrogen and inert ambience.

Referring to claim 6, Nagasawa et al discloses a second heat treatment of at least one hour, which reads on applicant's second heat treatment of 2 minutes or less, where the limitation of 2 minutes or less does not have an upper bound because of comprising language.

Referring to claim 7, Nagasawa et al teaches a silicon wafer.

7. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nagasawa et al (US 4,376,657) in view of Limb et al (US 5,352,615).

Nagasawa et al discloses all of the limitations of claim 4, as discussed previously in claims 1-4, except flow the inert gas, first mixed gas and second mixed gas ranges from 2 to 50 slm.

In a method of denuding a semiconductor substrate, Limb et al teaches denuding by heating a substrate to a temperature of 1000-1250°C with a total gas flow rate during processing of 5-20 slpm and an inert gas **313** flows into the furnace, wherein oxygen partial pressure is low to remove native oxide (col 3, ln 20-45 and col 2, ln 55-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagasawa et al by using the gas flow rate taught by Limb et al because it results in a denuded substrate.

8. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nagasawa et al (US 4,376,657) in view of Jastrzebski et al (US 4,429,047) along with Falster (5,882,989).

Nagasawa et al discloses all of the limitations of claim 5, as discussed previously in claims 1-4, except the first heat treatment is from 5 to 100°C/min and a rate of cooling after the first heat treatment is from 5 to 100°C/min.

In a method for determining the oxygen content of a semiconductor material, Jastrzebski et al teaches silicon wafers were heated to 1300°C for one hour and cooled at a rate of 30°C/min (col 6, ln 15-50 and Fig 7). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagasawa et al with Jastrzebski et al cooling rate because a minimum cooling rate is needed to maintain the oxygen in interstitial potions in the lattice.

In a method of preparing silicon wafers having a controlled distribution of oxygen precipitate nucleation centers, Falster annealing out nucleation centers at a temperature of at least 1000°C, where the heating rate is at least 10°C per minute (col 4, ln 10-26). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagasawa et al with Falster's heating rate because to prevent some or all of the oxygen precipitate nucleation centers from stabilizing by the heat treatment (col 4, ln 27-35).

9. Claims 17-19, as interpreted by the examiner, are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Matsushita (4,193,783).

Iida et al discloses a method of growing a silicon single crystal, where the temperature gradient in an in-crystal descending temperature zone in the vicinity of the solid-liquid interface was set as the gradient at the edge of the ingot was 45.0 (°C/cm) and the gradient at the center of the ingot was 42.0 (°C/cm) and pulling rate was increased resulting in an Oxidation-induced stacking fault (OSF) to appear at a circumferential part. Iida et al also teaches wafers were sliced from the ingot and measured for defect density (col 14, ln 20-67; col 15, ln 1-15 and FIG 10A).

Iida et al does not disclose extending an area in which delta (Oi) is greatly increased as compared to that of other areas, wherein the delta (Oi) is a difference between an initial oxygen concentration and oxygen concentration after heat treatment with a predetermined thermal history.

In a method of treating a silicon single crystal ingot, Matsushita teaches an ingot **2** is annealed with heat applied for at least 15 hours at a temperature of 1000°C in an atmosphere of nitrogen, this reads on applicant's heat treatment with a predetermined thermal history (col 2, 28-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida et al with Matsushita because lattice defects do not arise in the silicon wafer during subsequent manufacturing and impurities are substantially removed after the heat treatment (col 3, ln 15-30). It is inherent the invention taught by the combination of Iida et al and Matsushita to extend an area in which delta is greatly increased as compared to that of other area because the combination of Iida et al and Matsushita teaches a similar heat treatment as applicant and similar method of making a silicon ingot with a OSF ring at the circumferential part.

Referring to claim 18, the combination of Iida et al and Matsushita teaches a heat treatment of at least 15 hours at a temperature of 1000°C in an atmosphere of nitrogen, this reads on applicant's heat treatment at 1000°C for 64 hours in N_2.

Referring to claim 19, it is inherent to the combination of Iida et al and Matsushita to have an area in which delta is greatly increased is formed to occupy 20 to 90% of a diameter of the ingot because the combination of Iida et al and Matsushita teaches a similar heat treatment as applicant and similar method of making a silicon ingot with a OSF ring at the circumferential part.

10. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Matsushita (4,193,783) as applied to claims 17-19 above, and further in view of Nagasawa et al (US 4,376,657).

The combination of Iida et al and Matsushita teaches moving an oxidation-induced stacking fault (OiSF) ring from the center of a single crystalline growth axis by increasing the rate of pulling and a heat treatment in a N_2 ambience at 1000°C for 64 hours, where the first area and second area in which delta is inherently increased because the combination of Iida et al and Matsushita teaches a similar heat treatment and pulling process as applicant and forming wafers by slicing the ingot, as discussed previously in claims 17-19 above.

The combination of Iida et al and Matsushita does not teach carrying out a first heat treatment on a wafer at a temperature equal to or higher than 1200°C and carrying out a second heat treatment on a wafer by rapid thermal annealing at a temperature equal to or lower than 800°C.

In a method of making a fault-free surface in semiconductor devices, Nagasawa et al discloses a single crystal silicon wafer is annealed in a non-oxidizing atmosphere at a temperature in the range of 950-1300°C for more than ten minutes and the wafer next annealed at a temperature in the range of 600°-800°C for at least one hour (col 3, ln 54-68 and claim 1 and col 4, ln 37-44). Nagasawa et al also discloses annealing at 1270°C for two hours followed by a second anneal at 650°C (FIG 5 and col 5, ln 19-40). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the invention taught by the combination of Iida et al and Matsushita with Nagasawa's heat treatment because defects are reduced in the wafer (col 5, ln 40-55).

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Schrems (US 6,040,211) teaches annealing at a rate of 70°C/min to a temperature of 1100°C-1200°C in argon, hydrogen, or nitrogen to reduce costs and shorten anneal times (col 5, ln 1-20).

Falster (6,336,968) teaches heating a wafer to a temperature above 1150°C and cooling to a temperature greater than 950°C, where the cooling step may be carried out in the same atmosphere as the heating step and where suitable atmospheres include nitriding atmospheres, oxidizing atmospheres or non-oxidizing, non-nitriding atmospheres (Ar, He, Ne) and combinations thereof (col 5, ln 10-67).

Hourai et al (US 5,954,873) teaches an OSF ring appears at the outermost periphery of a wafer at a high velocity pulling rate (col 6, ln 1-15) and the diameter of the OSF ring varies depending on the pulling rate of the crystal and diameter shrinks with decreasing pulling rate (col 4, ln 40-58) and a OSF ring position related to the pulling velocity and temperature gradient (Fig 1A,B, C and Fig 2).

Mitani et al (US 5,478,408) teaches a high temperature treatment at a temperature of 1100-1200C for 1-25 hours in a N_2 of O_2 atmosphere, followed by a second low temperature treatment at a lower temperature of 650-800°C for 2-10 hours in a N_2 or O_2 (col 6, ln 45-55).

Adachi et al (US 5,931,662) teaches annealing in a diluted oxygen environment, such as O_2/Ar or O_2/N_2, to facilitate the separation of wafer from one another after annealing and does not cause cracking (col 10, ln 35-55) and a sustained heating at a temperature in excess of 1100°C followed by a ramp down to a temperature of 500°-900°C (col 11, ln 5-15)

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

mjs
July 3, 2002

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